

What is claimed is:

1. A structure for the utilization of one or more scalability techniques operable to enhance one or more digital video frames of a base layer of a digital video system, comprising:
  - one or more enhancement layers, wherein at least a first enhancement layer of the one or more enhancement layers is coupled to the base layer and is operable to be coupled to every other enhancement layer, and wherein each enhancement layer of the one or more enhancement layers comprises one or more enhanced frames of digital video;
  - a first sequence of one or more enhanced frames, said first sequence operable to be enhanced by selection of one or more scalability techniques; and
  - for each of the one or more scalability techniques, a mechanism for determining a number of the one or more enhanced frames of the first sequence that correspond to a scalability technique of the one or more scalability techniques.
2. The structure of claim 1, wherein two of the one or more scalability techniques are SNR scalability and temporal scalability.

3. The structure of claim 1, wherein each enhancement layer of the one or more enhancement layers comprises one or more SNR frames and one or more temporal frames.

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4. The structure of claim 1, wherein each scalability technique of the one or more scalability techniques is operable to use frames from the one or more enhancement layers.

- 10 5. The structure of claim 1, wherein a scalability technique of the one or more scalability techniques is selected based upon one or more criteria, said criteria further comprising one or more of

- 15 a motion function,  
a frame separation function,  
a visual quality gain with a SNR scalability function, and  
a bitrate of the enhancement layer function.

- 20 6. The structure of claim 1, wherein the one or more scalability techniques is selected in accordance with a comparison of a metric of the one or more scalability techniques to a threshold.

7. The structure of claim 6, wherein the metric further comprises:

within an enhancement layer of the one or more enhancement layers, if a frame  $i$  is a current frame encoded in a previous layer, and  $p_p(i)$  is a previously coded frame in the previous layer, the metric of the frame  $i$ ,  $F(i)$ , is formulated as

$$F(i) = \alpha F_M(p_p(i), i) + \beta F_s(p_p(i), i) - \lambda F_{SNR}(i) + \gamma F_R$$

where  $F_M(p_p(i), i)$  is a motion function,  $F_s(p_p(i), i)$  is a frame separation function,  $F_{SNR}(i)$  is an SNR visual quality function,  $F_R$  is a bitrate service function, and  $\alpha$ ,  $\beta$ ,  $\lambda$ , and  $\gamma$  are corresponding coefficient weights of one or more of the motion function, the frame separation function, the visual quality gain with the SNR scalability function, and the bitrate of the enhancement layer function.

8. The structure of claim 7, wherein what scalability technique of the one or more scalability techniques to use at frame  $i$  is determined in accordance with:

if  $F(i) < F_{TH}$  use a first scalability technique of the one or more scalability techniques; and

if  $F(i) > F_{TH}$  use a second scalability technique of the one or more scalability techniques.

9. The structure of claim 8, wherein the first scalability technique is SNR scalability and the second scalability technique is temporal scalability.

10. The structure of claim 7, wherein as an average motion vector magnitude increases, a value of the motion function also increases.
- 5 11. The structure of claim 7, wherein as a frame separation magnitude increases, a value of the frame separation function also increases.
12. The structure of claim 7, wherein the SNR visual quality service function is defined as
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- $$F_{\text{SNR}}(i) = \text{PSNR}_{\text{EnhancementLayer}}(i) - \text{PSNR}_{\text{PrevLayer}}(i)$$
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- where a  $\text{PSNR}_{\text{EnhancementLayer}}(i)$  is a Peak Signal to Noise Ratio (PSNR) value obtained by encoding the current frame  $i$  using SNR scalability in the enhancement layer and  $\text{PSNR}_{\text{PrevLayer}}(i)$  is a Peak Signal to Noise Ratio (PSNR) obtained for frame  $i$  in the previous layer.
13. The structure of claim 7, wherein the bitrate service function is a bitrate of the enhancement layer.
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14. The structure of claim 1, wherein if an enhancement frame of the one or more enhancement frames is selected and is not an SNR enhancement frame, then a copy of an SNR enhancement frame from a previous layer is replicated to a current layer at the same time
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- instance as in the previous layer.

15. A structure for the utilization of SNR scalability and temporal scalability operable to enhance one or more digital video frames of a base layer of a digital video system, comprising:

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one or more enhancement layers, wherein at least one enhancement layer of the one or more enhancement layers is coupled to the base layer and is operable to be coupled to every other enhancement layer, and wherein each enhancement layer of the one or more enhancement layers comprises one or more temporal enhanced frames and one or more SNR enhanced frames; and

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a first sequence of one or more enhanced frames, said first sequence operable to be enhanced by selection of the one or more SNR enhanced frames and the one or more temporal enhanced frames;

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wherein the one or more SNR enhanced frames and the one or more temporal enhanced frames are operable to be selected based upon one or more criteria, said criteria comprising one or more of

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a motion function,  
a frame Separation function,  
a visual quality gain with a SNR scalability function, and  
a bitrate of the enhancement layer function.

16. The structure of claim 15, wherein a metric is operable to select the one or more SNR enhanced frames and the one or more temporal enhancement frames, said metric comprising:

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within an enhancement layer of the one or more enhancement layers, if a frame  $i$  is a current frame encoded in a previous layer, and  $p_p(i)$  is the previously coded frame in that layer, the metric of the frame  $i$ ,  $F(i)$ , is formulated as

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$$F(i) = \alpha F_M(p_p(i), i) + \beta F_s(p_p(i), i) - \lambda F_{SNR}(i) + \gamma F_R$$

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where  $F_M(p_p(i), i)$  is a motion function,  $F_s(p_p(i), i)$  is a frame separation function,  $F_{SNR}(i)$  is an SNR visual quality function,  $F_R$  is a bitrate service function, and  $\alpha$ ,  $\beta$ ,  $\lambda$ , and  $\gamma$  are the corresponding coefficient weights of one or more of the motion function, the frame separation function, the visual quality gain with the SNR scalability function, and the bitrate of the enhancement layer function..

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17. The structure of claim 16, wherein a scalability technique to use at frame  $i$  is determined by

if  $F(i) < F_{TH}$  use a SNR enhancement technique; and

if  $F(i) > F_{TH}$  use a temporal enhancement technique.

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18. The structure of claim 16, wherein as an average motion vector magnitude increases, the value of the motion function also increases.

19. The structure of claim 16, wherein as a frame separation magnitude increases, the value of the frame separation function also increases.

5 20. The structure of claim 16, wherein the SNR visual quality service function is defined as

$$F_{\text{SNR}}(i) = \text{PSNR}_{\text{EnhancementLayer}}(i) - \text{PSNR}_{\text{PrevLayer}}(i)$$

10 where a  $\text{PSNR}_{\text{EnhancementLayer}}(i)$  is a Peak Signal to Noise Ratio (PSNR) value obtained by encoding the current frame  $i$  using SNR scalability in the enhancement layer and  $\text{PSNR}_{\text{PrevLayer}}(i)$  is a Peak Signal to Noise Ratio (PSNR) obtained for frame  $i$  in the previous layer.

15 21. The structure of claim 16, wherein the bitrate service function is the bitrate of the enhancement layer.

20 22. The structure of claim 15, wherein if an enhancement frame of the one or more enhancement frames is selected and is not an SNR enhancement frame, then a copy of an SNR enhancement frame is replicated from a previous layer to a current layer.

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23. A method for the utilization of one or more scalability techniques operable to enhance one or more digital video frames of a base layer of a digital video system, further comprising:
- 5 coupling at least one enhancement layer of one or more enhancement layers to the base layer, wherein each enhancement layer of the one or more enhancement layers is operable to be coupled to every other enhancement layer of the one or more enhancement layers and comprises one or more enhanced frames of digital video;
- 10 enhancing a first sequence of one or more enhanced frames by selection of one or more scalability techniques; and
- for each of the one or more scalability techniques, determining a
- 15 number of the one or more enhanced frames of the first sequence that correspond to a scalability technique of the one or more scalability techniques.
24. The method of claim 25, wherein selection of the one or more scalability techniques is performed in accordance with a comparison of
- 20 a metric of the one or more scalability techniques to the threshold.



25. The method of claim 26, wherein the metric further comprises:

within an enhancement layer of the one or more enhancement layers, if  
a frame  $i$  is a current frame encoded in a previous enhancement layer,  
and  $p_p(i)$  is a previously coded frame in the previous enhancement  
layer, the metric of the frame  $i$ ,  $F(i)$ , is formulated as

$$F(i) = \alpha F_M(p_p(i), i) + \beta F_s(p_p(i), i) - \lambda F_{SNR}(i) + \gamma F_R$$

where  $F_M(p_p(i), i)$  is a motion function,  $F_s(p_p(i), i)$  is a frame separation  
function,  $F_{SNR}(i)$  is an SNR visual quality function,  $F_R$  is a bitrate service  
function, and  $\alpha$ ,  $\beta$ ,  $\lambda$ , and  $\gamma$  are corresponding coefficient weights of one  
or more of the motion function, the frame separation function, the visual  
quality gain with the SNR scalability function, and the bitrate of the  
enhancement layer function.

26. The structure of claim 25, wherein if an enhancement frame of the one  
or more enhancement frames is selected, further comprising:  
replicating a copy of an SNR enhancement frame from a previous layer  
to a current layer.

27. A method for the utilization of SNR scalability and temporal scalability  
operable to enhance one or more digital video frames of a base layer  
of a digital video system, comprising:

coupling at least one enhancement layer of one or more enhancement  
layers to the base layer, wherein each enhancement layer of the one or

more enhancement layers is operable to be coupled to every other enhancement layer of the one or more enhancement layers and comprises one or more temporal enhanced frames and one or more SNR enhanced frames; and

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enhancing a first sequence of one or more enhanced frames by selection of the one or more SNR enhanced frames and the one or more temporal enhanced frames; and

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selecting the one or more SNR enhanced frames and the one or more temporal enhanced frames based upon one or more criteria, said criteria comprising one or more of

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a motion function,  
a frame Separation function,  
a visual quality gain with a SNR scalability function, and  
a bitrate of the enhancement layer function.

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28. The structure of claim 30, wherein if an enhancement frame of the one or more enhancement frames is selected, replicating a copy of an SNR enhancement frame from a previous layer to a current layer.